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Manitoba Plant Disease Control Guide

for Cereals, Potatoes and Special Crops

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Principles of Disease Control

Disease losses are serious every year in Manitoba. They result in reduced crop yields and marketability and account for an annual five per cent loss of cereal and special crops. Diseases occur during planting, growing, harvesting and storing. In high disease years, fields may suffer a 100 per cent loss.

A disease can be defined as any process that interferes with a plant's normal growth. Disease may cause severe root rot resulting in death of the plant or may cause only slight plant damage.

There are two broad categories of plant diseases.

a) Non-infectious disease caused by:
   1. nutrient deficiencies
   2. extremes of temperature, hot or cold
   3. excess or deficiency of water.

b) Infectious diseases caused by:
   1. microscopic organisms such as fungi, bacteria, viruses and nematodes
   2. less common causes such as mycoplasma-like organisms (MLO), slime moulds and parasitic plants.

Most micro-organisms are beneficial for natural decay and relatively few cause diseases. In Manitoba, fungi are the principal disease-causing organisms. Fungi cause stem rust, leaf rust and smut diseases of cereals; root rot of cereals and special crops; and sclerotinia disease of canola and sunflowers. Ring rot of potatoes is caused by a bacterium. Diseases caused by virus include barley yellow dwarf disease of wheat, barley and oats, and mosaic of numerous ornamentals. Flame chlorosis, an important new disease of barley, is suspected to be caused by a virus but has yet to be confirmed. Nematodes have not been troublesome in Manitoba except on sugar beets and greenhouse crops.

In Manitoba the only significant disease suspected to be caused by a mycoplasma-like organism (MLO) is aster yellows of barley, wheat, canola, buckwheat, flax, lettuce, carrots and celery. Serious yield losses rarely occur in the cereal and special crop hosts but aster yellows may be very destructive to vegetable crops.

Parasitic plants seldom cause crop diseases but can cause severe damage to forest trees such as dwarf mistletoe of Jackpine and spruce. Dodder is a parasitic plant which occasionally attacks flax.

Slime moulds are rarely a cause of plant disease, but slime mould of strawberries is occasionally encountered in Manitoba.

Disease Development

Infectious disease results when susceptible plants are invaded by a disease-causing organism. Weather (moisture, temperature, wind and light) directly influences the severity of plant disease. Winds spread infectious disease organisms such as rust or smut spores. Splashing rain spreads bacteria. Viruses and MLO are often spread by insects such as aphids and leaf hoppers.

In order for disease to develop, conditions must be suitable for infection. For spore germination and subsequent infection, most fungi and bacteria require free water which can come from dew, rain or fog on the plant surface. Cloudy, foggy weather with moderate temperatures favours many leaf diseases. Root rot develops most readily under extremes of wet or dry soils. In both cases plant growth is under stress and the plant is more vulnerable to disease-causing organisms. Plants under nutrient stress are often more susceptible to infections so some diseases

can be partially controlled by applications of fertilizer. For example, browning root rot of wheat is reduced by an application of phosphate and root rot of wheat can be controlled by potassium chloride applications. When supplied with excess nutrients (especially nitrogen) the plant develops a dense canopy and the risk of disease such as stem rot in canola increases.

Disease Control

The life cycle of a disease-causing organism can be halted by providing an unfavorable growing environment for the organism or by removing the plant host.

Disease control is best achieved by following these recommendations:

a) Avoid the disease organism

1. Select a planting site or field not contaminated by the disease-causing organism.
2. Use plant varieties that are disease-resistant.
3. Bury infected crop residue after harvest.
4. Practice crop rotation.
5. Plant early.
6. Harvest at proper time and store crop under ideal storage conditions.

b) Exclude the disease organism

Certified seed for many crops is inspected for disease. When the amount of disease exceeds tolerance limits, the field of seed is not certified. For example, potatoes with ring rot of potatoes have a zero tolerance and will not be certified.

Quarantine laws prevent disease spread from country to country or province to province.

c) Remove the disease-causing organism

1. Diseased plants can be removed from fields by roguing. (For example, potato fields are rogued for virus-infected plants.)
2. Separate diseased plant part(s) from seeds. (Ergot can be cleaned out of rye seed by a specific gravity seed cleaner).
3. Soil fumigation eliminates disease-causing fungi, bacteria and nematodes.
4. Insecticides can be used to stop an invasion of vectors (aphids, leaf hoppers) that carry viruses and mycoplasmas.

d) Protect the crop plant from disease

Fungicides and bactericides kill disease-causing fungi such as smut or blight on seeds and provide some protection from soil borne fungi which cause seedling decay and blight. Leaves and stems can be sprayed to prevent infection by fungi and bacteria causing diseases such as white mould, early blight, bacterial blight and leaf spot.

There are only a few diseases of special crops where fungicides (other than seed treatment) are recommended.

Sclerotinia disease of field beans and canola can be controlled by an application of benomyl (Benlate) or iprodione (Rovral) at flowering time. Mancozeb (Dithane M45) is registered for control of leaf rust, tan spot and septoria of wheat. Propiconazole (Tilt) is registered for control of leaf diseases of winter wheat, semi-dwarf, soft white wheat and barley. Triadimefon (Bayleton) is registered for control of rust and powdery mildew of winter wheat.

Recommendations for fungicide applications on field crops and potatoes are summarized in Table 3. Seed treatments for cereals and special crops are presented in Table 1.

e) Disease control through crop rotation

Crop rotation alternating cereal crops with broadleaf special crops reduces the incidence of root rot. Many special crops are subject to root rot and sclerotinia white mould and thus cannot be grown in the same crop rotation or must be spaced at least three years apart. These include: fababeans, field beans, field peas, lentils, mustard, canola, safflower, soybeans and sunflowers.

Table 2 indicates the number of years that various crops should be spaced apart in a crop rotation for disease control.

A crop rotation is also affected by herbicide residue. A detailed chart on crop rotation integrating disease, herbicide, volunteer crop and fertility consideration is available from Manitoba Agriculture Publications, 411 York Avenue, Winnipeg, Manitoba R3C 3M1.

Vegetable crop disease control recommendations are included in the Vegetable Crop Production Guide available from Manitoba Agriculture Publications.

The Strawberry and Raspberry Spray Calendars list disease control recommendations for strawberries and raspberries. Recommendations for control of turf, lawn grass and greenhouse diseases are available from the Manitoba Agriculture Plant Pathology Laboratory.

Fungicide Formulations

Most fungicides are not water soluble and must be made into a formulation (preparation) for use. The most common formulations are listed below. Each formulation abbreviation is given in parentheses following the name.

Wettable powder (WP). Many fungicide formulations are wettable powders consisting of solid fungicide and a wetting agent. When mixed with water the powder forms a suspension. Many of these suspensions settle out quickly, so an agitator is needed in the spare tank to keep the articles in suspension.

Dusts (DU). These powders are mixed with inert ingredients to form a product with a low content of active material.

Granules (G). In these formulations, the active ingredient is incorporated into small granules of inert material such as clay. Fungicides like Terraclor are formulated this way for application to the soil.

Solutions or soluble powders (Sn) are products where the fungicides are water soluble.

Liquid concentrates (LC) are concentrated solutions (see above).

Flowables (Su) are insoluble fungicides ground into a very fine product, usually by a wet grinding process. These particles are nearly colloidal in size and are suspended in water to form a thick liquid. They remain suspended in water for relatively long periods of time, but should be agitated before use. Because flowables are dust-free, easy to mix, remain in suspension longer, and may also resist washing off the plant better than the wettable powders, they are increasing in popularity over wettable powders.

Fumigants are liquids that turn into a gas after application. They are generally used for soil fumigation.

Mode of Action of Fungicides

The action of most fungicides takes place outside the host. These fungicides are called "protectant fungicides". Most fungicides sprayed on leaves and fruit are of this type.

"Therapy" is the term used to describe chemical action inside the host. Relatively few fungicides use this mode of action.

Most protectants fungicides are relatively stable by themselves. Generally they are relatively insoluble in water and resist removal or chemical change by water, yet must be toxic to fungi. Often a chemical change is brought about by the fungus, host or environment before toxicity occurs. Toxicity simply means the ability to damage the fungus cells.

Fungicides may act in several different ways to produce a toxic reaction.

(1) Some may slow down or stop cell wall formation. Certain antibiotics inhibit bacteria through this mode of action.

(2) The permeability of the cell wall may be affected, causing nutrient materials to leak from the cell.

(3) Some fungicides may combine with essential metals in such a way that they become unavailable for normal cell functions, including the functioning of essential enzymes.

(4) Other fungicides may inhibit respiration or nuclear division, or may break dormancy of spores.

Some fungicides may also be toxic to plants. This is called phytotoxicity. For example, folpet (Phalton) is chemically related to captan, and is a more active fungicide, however, its use is limited because it is more phytotoxic. Formulations of maneb and zinc are less phytotoxic to many vegetables than formulations that contain

only maneb. Sometimes the method of formulation may make a fungicide less phytotoxic.

Application of Fungicides

Seed treatment, spraying, dusting, soil treatment, dipping, drenching and soil injection are the various methods of applying fungicides. The most common methods of application in Manitoba are seed treatment and spraying.

Disease Control

In control of smuts, seed of resistant varieties and seed of susceptible varieties free of smut should not require treatment. No yield benefit results from treating sound seed of a resistant variety. When smut is observed in a crop being used for seed, it should be treated.

If a producer uses seed of a susceptible variety and there is doubt as to smut or bunt infection, seed treatment is a wise precaution. Recommended intervals between treatments for the various crops can be found in the fungicide application section on page 23. Agriculture Canada Publication 1766/E 1984, *Smut Diseases of Wheat, Barley, Oats and Rye*, will aid in recognition of smut in the field.

Use a suitable chemical with a Pest Control Products Act number (PCP No.). Recommended chemicals are shown in Table 1. Seed treatment chemicals are poisonous so guard against inhaling dust or fumes and wear a mask. Wash with soap and water periodically to remove chemical lodging on hands and face while treating.

Thoroughly clean equipment used in moving treated grain before it is used for untreated grain. Empty chemical containers should be disposed of at an authorized pesticide container disposal site.

CAUTION: Treated grain must not be mixed with untreated grain for feed or sale. Treated leftover seed may be saved for planting the following year; otherwise it should be buried at a depth and location where it will not be accessible to animals or contaminate water supplies. Leftover treated seed from a previous year should be checked for germination percentage prior to planting because some seed treatments may reduce seed viability.

Seed treatment can have three purposes, although all three are seldom met in average cases. One of the major reasons for treating seed is to stop the growth of pathogens borne on the seed surface. Covered smut of barley, false-loose smut of barley, loose and covered smuts of oats, and bunt of wheat are pathogens borne on the seed surface. Seed treatment can inhibit the growth of these pathogens, greatly reducing the amount of infection of young seedlings. Seed treatment is the major control method for all of the seed-borne diseases listed above.

A second reason for treating seed is to protect the seed against soil-borne pathogens. This is especially important when conditions are unfavorable for the rapid germination and emergence of seed; because the longer the seed is in the ground, the greater the danger of seed rotting or seedling damping-off. (Damping-off is a rapid death of young seedlings.) Seed treatment is also very important for protecting damaged seed against soil-borne pathogens. Flax seeds with damaged seed coats are much more vulnerable to attack and destruction by soil-borne pathogens than are sound seeds.

A third reason for treating seed is to destroy internally seed-borne pathogens such as the loose smuts of barley and wheat. The protectant fungicides used to protect against surface-borne pathogens and soil-borne pathogens are ineffective against these internal infections. Carbathiin (Vitavax) is capable of entering the growing seedling. It moves systematically through the seedling and prevents the further development of loose smut fungus, which is systemic in the plant.

Seed may be treated by commercial seedsmen or on the farm. Commercial seed treatment may use a slurry treater or various automatic seed treaters. Commercial seedsmen using flowable fungicides should be sure to clean off the chemical metering cups every day to prevent a build

up of fungicide which causes low delivery rates.

On-farm treatment may use various home type or slurry mixers, but drill box seed treatment is popular because no extra steps are required. The seed is treated in the drill-box at planting time which eliminates the need for special seed treating equipment and avoids the problem of useless leftover seed. Caution must be exercised to ensure drill box seed treatment is used properly. Good disease control depends on even and uniform fungicide coverage of the seed. This is more difficult to accomplish in drill-box treatment because of the inadequate means of mixing the seed and fungicides. For effective drill-box treatment, fill the box with one third the quantity of seed and fungicide and mix carefully with a paddle. Repeat with the next third, and then the final third. The paddle should not be used for any other purpose. Store the paddle in a safe place where children and animals cannot get to it.

The most common and satisfactory on-farm seed treatment meters fungicide into the base of the auger used to fill the drill-box. This assures good mixing and coverage. If a powder is used, dust can cause irritation so adequate protective clothing and a chemical respirator should be used. If a liquid is used, there will be no dust problem.

All seed treatment requires certain basic precautions. Care should be used in handling seed treatment products; if not highly poisonous many are at least irritating to the eyes and nose. Treated seed is usually identified by the dye used in the chemical, and treated seed should not be fed to livestock or used for human food. Pesticide containers should be disposed of properly in a land fill or buried in an area where there is no surface drainage to nearby water sources. If seed treatment cannot be done outdoors, a well-ventilated room will do. Commercial seed treaters should have an adequate air exhaust system for treatment rooms. Workers exposed to seed treatment chemicals for long periods of time should wear an approved chemical mask and change the filter frequently. Recommended application rates should be followed carefully because higher rates may injure the seed and lower rates may not provide satisfactory disease control.

Spraying: Many different types of ground and air equipment can be used. The important thing is to get good coverage. A volume of 22 L/acre is usually used for aerial application and higher volumes for ground equipment.

Droplet size for aerial application should be 200 to 400 microns (1/64 to 1/128 in.) in diameter. Generally, the correct droplet size will result if nozzles are pointed back, appropriate nozzles are used, and pressures do not exceed 200 to 240 kPa (30 to 35 psi). Application should be made with the boom 1.9 to 2.5 m (6 to 8 ft.) above the crop.

Some plants have a waxy or hairy coating, making good coverage difficult. This is the case with wheat and canola leaves. The spray will often collect in large erect droplets which then run off. When this happens, it is often necessary to use wettable powders with a wetting agent, usually a spreader-sticker. Certain combinations of fungicides and spreader-stickers may work better than others. This type of information can usually be found on the label or in supplemental brochures. As spreader-stickers are usually incorporated in flowable formulations, adding a spreader-sticker to the spray tank is unnecessary.

Sclerotinia Disease

Sclerotinia sclerotiorum can cause serious damage to a great variety of broadleaf special crops including fababeans, field beans, field peas, lentils, mustard, canola, safflower, soybeans and sunflowers. Hosts of this disease are vegetable crops such as carrots, green beans, and garden peas, along with many weeds such as thistles, wild mustard, ragweed and burdock.

The pathogen overwinters in Manitoba soils by means of black, hard bodies or sclerotia. These bodies are variable in shape (round, flat, short, elongated) and measure from a few millimeters to several centimetres. Infection is caused two ways:

- by direct mycelial germination
- by airborne ascospores produced by inconspicuous, tiny mushrooms or apothecia.

Direct germination causes root infection and occurs primarily in sunflowers. This infection results in root rot and basal stem rot, which can be identified by a wet lesion at the stem base and a sudden wilting of the plant. Infection by ascospores causes head and stalk rot in sunflowers, and white mould or stem rot in other crops. Spore infection occurs under conditions of continuous heavy rainfall.

Airborne infections are further enhanced by the presence of senescent (old or dead) tissue such as florets of sunflower heads and flower petals of other crops that drop and become lodged in leaf axils. The germinating spore needs senescent tissue as a food base for the infection to be successful.

Sclerotinia diseases are partially controlled by the use of sclerotia-free seed and weed control as well as a minimum four year rotation between host crops. Airborne infections are further reduced by seeding to allow maximum air circulation and fast drying, and by timely spraying with recommended chemicals on approved crops. Sclerotinia wilt damage on sunflowers is reduced by using minimum populations planted at maximum distances.

Crop Rotation

Alternating of broadleaf and cereal crops is generally recommended. Further information on crop rotation can be obtained from the bulletin *Crop Rotation Chart.*

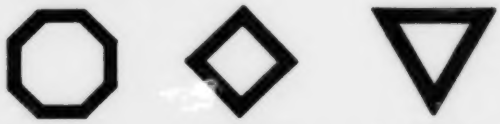
Table 2 details some common diseases of Manitoba field and specialty crops which occur on more than one crop. It also shows the longevity of these field disease in the absence of a susceptible host.

Safe Use of Fungicides

Toxicity of Fungicides

All pesticide container labels carry safety symbols indicating the degree of hazard and risk to the user.

The categories of risk are indicated by the following symbols:



Danger *Warning* *Caution*

Products that are the most toxic and pose the highest risk to the user carry the **DANGER** symbol. **WARNING** and **CAUTION** are less dangerous, respectively. Where the risk is minimal, no symbol is required on the container label.

The **categories of hazard** are represented by the following symbols:

Poison *Corrosive* *Flammable* *Explosive*

Categories of Risk symbols are used in conjunction with **Category of Hazard** symbols on product labels. For example, the symbol at right would mean DANGER—EXPLOSIVE.

Because most pesticides are poisons, the remainder of this section explains the toxicity of the poison risk symbols and lists the type of safety equipment that should be worn by the user.

Poison Risk Symbols

DANGER – POISON

LD50* (see end of page for explanation)

- Oral, less than 500 mg/kg
- Dermal, less than 1000 mg/kg

Probable lethal dose for 68 kg (150 lb.) person:

- 7 drops to 28 mL (1 oz.) swallowed
- 7 drops to 85 mL (3 oz.) absorbed

Safety clothing to be worn: Respirator, goggles, clean coveralls, water repellent hat, rubber gloves, rubber boots

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WARNING – POISON

LD50* (see below)

- Oral, 500 to 1000 mg/kg
- Dermal, 1000 to 2000 mg/kg

Probable lethal dose for 68 kg (150 lb.) person:

- 28 to 85 mL (1 to 3 oz.) swallowed
- 85 to 200 mL (3 to 7 oz.) absorbed

Safety clothing to be worn: Goggles, clean coveralls, water repellent hat, rubber gloves, rubber boots

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CAUTION – POISON

LD50* (see below)*

- oral, 1000 to 2500 mg/kg
- dermal, 2000 to 5000 mg/kg

Probable lethal dose for 68 kg (150 lb.) person:

- 85 to 227 mL (3 to 8 oz.) swallowed
- 200 to 445 mL (7 to 16 oz.) absorbed

Safety clothing to be worn: Clean coveralls, water repellent hat, rubber gloves, rubber boots

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LD50 — a measure of toxicity that indicates the amount of pure pesticide that would produce a 50% mortality in a test animal population (rats, mice, guinea pigs).

Source: Pesticides Division, Agriculture Canada.

Eye Protection

The use of protective goggles is necessary and recommended when a full face mask is not worn.

Many goggles are chemical resistant. Some have specially treated lenses to reduce fogging. Others have anti-fogging ventilation. Prescription-type safety spectacles are also available. Side shields can be attached when necessary.

Gloves

Non-absorbent gloves should be worn at all times while handling, mixing and applying pesticides. Neoprene has been found superior to rubber in resisting the absorptive penetration of many substances associated with pesticides.

Other factors to be considered in selecting suitable gloves include sense of touch, wet grip, cut resistance and abrasion resistance. Gloves should fit snugly. Fabric wrist gloves should not be considered.

Footwear

Non-absorbent footwear should be worn when applying pesticides. The most suitable boot is knee length, acid and solvent resistant, and cleated or ribbed to prevent slippage.

Neoprene is considered superior to rubber in withstanding various acids and solvents.

Other Clothing

A major concern in agricultural pesticide spraying is the unwillingness of the applicator to wear some form of protective clothing, particularly under warm summer conditions. At the very least, coveralls should be worn along with gloves and a hat to minimize the hazard of dermally toxic (absorbed through skin) pesticides. The clothing should be changed and washed following spraying.

Disposable garments suitable for pesticide work are now available. Made of "Tyvek" polyethylene fibres, such clothing will provide protection against dermal exposure resulting from pesticide drift, splashing or spills. Lightweight and economical, disposable garments are available as coveralls, shirts, pants, headcovers and aprons.

Supplies of goggles, prescription type safety spectacles, neoprene gloves, boots and other protective clothing including hats are available from any one of the major safety supply companies listed below.

Availability

Many pesticide dealers stock personal protective equipment for pesticide use. In addition, several Manitoba safety supply companies provide a wide range of products. Some firms offer complete lines, while other specialize. The following Winnipeg companies can meet the needs of pesticide users:

- IPACO Safety Products — 775-8208
- Levitt-Safety Limited — 633-7228
- MSA Canada Incorporate — 632-7570
- McVicar Safety Supplies Ltd. — 889-3787
- Safety Centre Limited — 772-2495
- Safety Supply Canada — 453-7838

Check the telephone directory Yellow Pages for addresses and branch locations.

In case of accident or poisoning with any pesticide, contact your local hospital. For further information, contact:

Poison Control
Health Sciences Centre
Children's Centre
685 Bannatyne Avenue
Winnipeg, Manitoba
R3E 0W1
Phone: 1-787-2591

General Pesticide Recommendation

For proper pesticide use:

- Identify the pest problem.
- Use the recommended pesticide.
- Apply according to directions.

General Pesticide Guidelines

Know and observe the following guidelines:

- Never smoke while applying pesticides
- Avoid inhaling sprays or dusts. Wear protective clothing and a respirator. Additional detail on personal protective equipment is provided below.
- Sprayer lines carrying pesticides must not enter the operator's cab.
- Have soap, water and a towel available. Should concentrated product spill on skin, hands, face or eyes, wash immediately.
- Wash hands and face when leaving the treated area — before break periods, lunch or for comfort.
- Bathe or shower and change to clean clothing after working with pesticides. Wash clothing each day before re-using.
- Call a physician or get the patient to a hospital immediately if symptoms of illness occur during or shortly after pesticide application. Be sure to take along the product label or container.
- Store pesticides out of the reach of children.
- Store pesticides where there is no chance of contact with human food or livestock feeds. Do not store herbicides with insecticides, and avoid cross-contamination. Storage areas should be locked.
- Keep chemicals in their original container, never in unmarked containers or bottles used for food or drink.
- Never fill spray tanks directly from a drinkable water source such as a well or dugout.
- Follow proper container disposal methods. All containers should be triple-rinsed or pressure-rinsed, punctured to render the container non-reusable, and delivered to designated disposal sites.

Pesticide Container Disposal

Rinse all pesticide containers prior to disposal to reduce environmental contamination.

Triple Rinsing

Triple-rinsing renders used pesticide containers (metal, plastic, glass) more than 99.9% free of residues in most cases.

These steps should be followed:

1. Empty contents of the container in the spray tank and drain in a vertical position for 30 seconds.
2. Add a measured amount of rinse water or other dilutent so container is about 1/5 full.
3. Rinse the container thoroughly and pour into the spray tank.
4. Repeat the procedure three times. It should only take about five minutes in total.

5. Triple-rinsed containers should be punctured or broken to render them non-reusable. Paper should be rinsed once prior to disposal.

Pressure Rinsing

Pressure rinsers have the versatility to rinse all sizes of empty pesticide containers and can be lifted into position over the spray tank.

Pressure rinsers are designed to be thrust into the bottom of a metal can or plastic jug. Holes, situated laterally in the rinser tip, direct water from a pressurized source on to the inner sides of the container and effectively wash the residual pesticide into the spray tank. Some farmers have found it convenient to attach a rinser to the pump on their large water storage tank to minimize container handling.

A 30 second rinse with any of these pressure rinsers is convenient and just as effective as triple rinsing. Pressure rinsers have the added advantage of rendering containers useless by automatically puncturing them.

Disposal of Containers

Properly rinsed containers should be delivered to a designated pesticide container disposal site. Contact your ag rep or weed supervisor for the locations of pesticide container disposal sites in your municipality.

Pesticide Spills

If a pesticide spill appears to be a hazard to property or environment, call:

Environmental Management Branch
Building 2, 139 Tuxedo Avenue
Winnipeg, Manitoba
R3N 0H6
Phone: 945-4888 (24 hours)

Pesticide Drift

Pesticide drift can leave unwanted residues on adjacent crops, create a hazard to people and livestock nearby, and reduce the amount of material in the target area so that is it ineffective.

Those applying pesticides should make every effort to minimize or prevent pesticide spray drift by:

- correct calibration and maintenance of spray equipment
- correct operation of the equipment
- being aware of the toxicity of the pesticide being used
- being aware of the weather conditions.

Custom Application – Ground and Air

Custom applicators must be licensed by Manitoba Agriculture. For further information, contact Andy Kolach, Emtomology Section at 945-3859.

It is an offense under the Federal Pest Control Products Act to use a control product under unsafe conditions. Precautionary practices must be heeded at all times to prevent drift. Extra precautions should be taken when using insecticides applied by air, especially those known to be toxic to honeybees — e.g. Sevin (carbaryl).

Do not spray in winds above 15 km/h (9 mph). Within 1/2 hour of sunrise or sunset, do not spray in winds above 10 km/h (6 mph).

Tank Mixes

A tank mix is two separately purchased pesticides mixed in the sprayer tank, as opposed to one preformulated mixture sold by the manufacturer. For specific details on tank mixing, refer to label recommendations provided by the pesticides manufacturer.

INDEX OF SEED TREATMENTS

Chemical	Treatment	Product Name
Benomyl, captan, lindane	Su, Du	Gammasan plus Flow Rapeseed Treatment
	Du	Gammasan Seed Treatment Powder
Benomyl, thiram	Wp	Benlate T Benomyl – Thiram Fungicide Seed Dressing
Benomyl, thiram, lindane	Du	Thiralin-plus
lindane	Du	Ipco Benolin-R Insecticide Fungicide Dust
Captan	Su	Chipman Flowable Seed Treatment
	Wp	Captan 75 Seed Protectant
	Su	Captan SP-4 Flowable
	Su	Chipman Agrox I.F. Dual Purpose Seed Treatment
Captan, lindane, diazinon	Du	Agrox D-L Plus Insecticide/Fungicide Drill and Seed Treatment Powder
	Du	Pickseed DLC Seed Box Treatment
	Du	Drillbox Diazinon-Lindane Plus Captan Seed Treatment Powder
	Du	Ciba-Geigy DCL Slurry Dual Purpose Seed Treatment
	Du	Pfizer – DCL Drill Slurry Dual Purpose Seed Treatment
	Du	Co-op Rapeseed and Mustard Seed Treatment
	Du	Co-op D-L & C Drill Box Seed Treatment
	Wp	Chipman B-3 Dual Purpose Seed Treatment
Captan, thiophanate-methyl diazinon	Du	DCT Dual Purpose Seed Treatment
Carbathiin	Sn	Vitavax Solution Seed Protectant
	Sn	Vitavax Single Solution
Carbathiin, lindane	Sn	Vitavax Dual Solution
Carbathiin, thiram	Du	Vitavax Powder
	Su	Anchor

INDEX OF SEED TREATMENTS		
Chemical	**Treatment**	**Product Name**
Carbathiin, thiram, lindane	Du	Vitavax RS Powder
	Su	Vitavax RS Flowable
	Du	Vitavax Dual Powder Seed Protecant
Carbofuran	Gr	Furdan CR-10
	Gr	Furadan 5G
Iprodione, lindane	Sn	Rovral ST
Lindane	Wp	Lindane
Maneb	Wp	Agrox NM Drill Box & Slurry Seed Treatment Powder
	Su	Agrox Flowable Seed Treatment Fungicide
	Du	Pool NM Drill Box Seed Treatment
	Du	Pool Seed Treat Powder
	Wp	Manzate D Agro, Fungicide
	Du	Co-op NM Drill Box Seed Treatment
	Su	Mergamma Flowable Dual Purpose Seed Treatment
	Du	Pool Dual Purpose Seed Treatment
	Du	Mergamma NM Drill Box Purpose Seed Treatment
Mancozeb	Wp	Manzate 200 Mancozeb Fungicide
Metiram	Wp	Polyram 7 Dust
	Su	Polyram 7 Fungicide Seed Protectant
Terbufos	Gr	Counter 5G
Thiabendazole, thiram, lindane	Sn	Premier
Thiram	Wp	Thiram 76 WP Wettable Powder Fungicide
	Su	Thiram 320 Flowable Fungicide
	Wp	Thiram 75-WP
	Wp	Pfizer Thiram 75 Seed Fungicide DU Thiram 320

Tank mixes can include the use of two similar pesticides (such as herbicides) or may include two different pesticides (such as an insecticide combined with a fungicide). Vegetable growers use several tank mixes of insecticides and fungicides.

Use only tank mixes that are registered and recommended as mixes. Use of unregistered tank mixes can result in crop injury or reduced pest control. When tank mixing, observe all precautions and restrictions on both pesticide labels. Follow the longest time period for re-entry and harvest wait period.

Disease Control in Cereals, Special Crops and Potatoes

Barley

Smuts – Treat seed of varieties listed as having fair resistance to loose or surface bore smuts (covered and false loose) with a suitable fungicide every three years. Varieties with poor resistance should be treated every two years. (See Table 1.)

Leaf Spots – Fungi which cause leaf spot diseases of barley overwinter on barley straw, stubble and on seed. Treat seed from infected fields to reduce seedling infection. (See Table 1.) Treat seed from infected fields to reduce seedling infection. Planting barley after barley enhances the potential severity of net blotch and spot blotch, particularly in younger plants. (See Table 2.) For a list of recommended foliar fungicides see Table 3.

Ergot – If ergot has been a problem, rotate with a non-susceptible crop for one year to reduce disease incidence. (See Table 2.) Cultivate fields after harvest to bury ergot bodies to a depth of at least 5 cm (2 in.) and mow grass headlands and roadsides before heading to reduce ergot spread. If the seed source is known to contain ergot bodies, storage for more than one year reduces their viability to almost zero. Levels of ergot bodies in the harvested grain above 0.1% by weight may be toxic in livestock feed.

Oats

Early seeding and heavier seeding rates will reduce damage by barley yellow dwarf virus. Current varieties have good resistance to smut, leaf rust and stem rust.

Rye

Seed Rot and Seedling Blights – Rye seed should be treated with a suitable treatment product to reduce seed rot, seedling blights and stem smut. (See Table 1.)

Ergot – For ergot problems, rotate with a non-susceptible crop for one year to reduce incidence. (See Table 2.) Cultivate fields following harvest to bury ergot bodies to a depth of at least 5 cm (2 in.) and mow grass headlands and roadsides before heading to reduce spread. If the seed source is known to contain ergot bodies, storage for more than one year will reduce their viability to almost zero. Levels of ergot bodies in the harvested grain above 0.1% by weight may be toxic in livestock feed.

Triticale

Ergot – Triticale is slightly more susceptible to ergot than wheat. If this is a problem, rotate with a non-susceptible crop for one year to reduce incidence. (See Table 2.) Cultivate fields following harvest to bury ergot bodies at least 5 cm (2 in.). Mow grass headlands and roadsides before heading to reduce spread. If the seed source contains ergot bodies, storage for more than one year reduces their viability to almost zero. Ergot body levels in the harvested grain above 0.1% by weight may be toxic in livestock feed.

Wheat

Loose Smut or Bunt – Seed of varieties with fair resistance to loose smut or bunt should be treated with a suitable fungicide every three years. Those with poor resistance should be treated every two years. (See Table 1.)

Smut – Semi-dwarf wheat varieties are all very susceptible to loose smut and bunt. All seed of semi-swarf wheat should be treated annually with the systemic fungicide carbathiin, available as Vitavax and Vitaflo, for prevention of smut.

Ergot – If ergot has been a problem rotate with a non-susceptible crop for one year to reduce incidence. (See Table 2.) Cultivate fields following harvest to bury ergot bodies to a depth of at least 5 cm (2 in.) and mow grass headlands and roadsides before heading to reduce spread. A seed source known to contain ergot bodies should be stored for more than one year to reduce viability to almost zero. Levels of ergot bodies in harvest grain above 0.1% by weight may be toxic in livestock feed.

Fusarium head blight – Fusarium head blight can develop in a wheat crop when infected debris is present. Durum and semi-dwarf wheats are usually more susceptible to head blight. Experience in southern Ontario indicates that overwintered corn debris can result in the most damage to the subsequent crop. To minimize the risk of fusarium head blight in an outbreak area, incorporation of debris and rotations away from wheat and corn may be beneficial.

Tan Spot/Septoria Leaf and glume blotch – In Manitoba, tan spot and septoria diseases are becoming more prevalent in wheat. The causal organisms are fungi which survive from one year to the next in infected wheat straw and stubble. To reduce disease severity, rotations away from wheat for at least one year are recommended. Early-season outbreaks of tan spot/septoria have been found in fields cropped to wheat the previous year. For a list of recommended foliar fungicides see Table 3.

Powdery mildew – Powdery mildew is not normally a problem in spring wheat but has been observed at higher levels in winter wheat and semi-dwarf wheat varieties. Mildew levels sufficient to cause damage may occur in dense crops under moderate to high humidity. For a list of recommended foliar fungicides see Table 3.

Wheat Streak Mosaic – This virus disease is now more prevalent in southwest Manitoba. Wheat streak mosaic is spread from spring wheat to winter wheat in the fall and from winter wheat back to spring wheat in the spring by a mite species. Damage can be reduced greatly in both crops by not seeding winter wheat near spring wheat until the latter is completely ripe. It is also recommended to eradicate volunteer wheat and barley and to keep land free of living plants for at least one week before seeding.

Stem and Leaf Rust – All semi-dwarf wheat varieties currently grown in Manitoba are rust-resistant. Neepawa wheat has poor resistance to

leaf rust and Katepwa has only fair resistance. For a list of recommended foliar fungicides see Table 3. Leaf rust can cause yield loss to susceptible varieties of spring wheat under favorable conditions for disease outbreak.

Winter Wheat

Follow a crop rotation of at least one year between wheat crops. Avoid other cereal crops in the rotation to control soil-borne diseases.

Rust – All currently registered varieties of winter wheat are susceptible to stem and leaf rust. In some years severe losses may occur due to rust infection. Losses as high as 40% have been recorded in Manitoba under severe disease conditions. For a list of recommended foliar fungicides see Table 3.

Tan Spot/Septoria leaf and glume blotch – In Manitoba, tan spot and septoria diseases are becoming more prevalent in wheat. The causal organisms are fungi which survive from one year to the next in infected wheat straw and stubble. To reduce disease severity, rotations away from wheat for at least one year are recommended. Early-season outbreaks of tan spot/septoria have been found in fields cropped to wheat the previous year. For a list of recommended foliar fungicides see Table 3.

Loose Smut or Bunt – Seed of varieties with fair resistance to loose smut or bunt should be treated with a suitable fungicide every three years. Those with poor resistance should be treated every two years. (See Table 1.)

Canola (Rapeseed)

Producers should use canola seed from disease-free fields. The seed should be treated to control seed rot and seedling blights and to prevent the introduction and establishment of blackleg into blackleg-free areas. (See Table 1). Where blackleg is already established in an area, seed treatments are ineffective in disease control. In these areas stubble should be incorporated to expedite rapid decomposition of canola trash and to reduce the liberation of ascospores into the air. Do not sow canola or rapeseed adjacent to canola or rapeseed stubble.

To control blackleg, follow a crop rotation of at least four years and control volunteer plants between canola crops. To control sclerotinia and other soil-borne diseases, follow a rotation of four years and avoid fababeans, field beans, field peas, forage legumes, lentils, mustard, safflower, soybeans and sunflowers. See Table 3 for a list of recommended foliar fungicides.

Fababeans

Fababeans are susceptible to a number of diseases which attack other broad leaved crops. Producers should use seed known to be free of ascochyta to avoid losses from seed-borne ascochyta blight. Following a crop rotation of at least four years between successive crops of fababeans will control ascochyta, anthracnose and other soil-borne diseases. Because of sclerotinia disease, field beans, field peas, lentils, mustard, canola, safflowers, soybeans and sunflowers should be avoided in the rotation.

Field Beans

Bacterial blight – Use pedigreed seed or seed known to be free from bacterial blight.

Bean Rust – Heavy infection of rust reduces yield, particularly of pinto beans. After harvest, turn under all bean refuse as completely as possible.

Sclerotinia Disease (white mould) – Avoid fababeans, field peas, lentils, mustard, canola, safflowers, soybeans and sunflowers in the rotation. Fungicides may be applied as a protectant treatment. (See Table 3.) Avoid dense foliage favorable for disease development by resisting nitrogen. Follow a crop rotation of four years to control sclerotinia and other soil-borne diseases.

Field Peas

Field peas are susceptible to a number of diseases which attack other broad-leaved crops. Use of disease-tested seed is strongly recommended to avoid losses from seed-borne ascochyta. Producers should follow a crop rotation of at least four years between successive pea crops to control ascochyta, anthracnose and other diseases. Plant peas as far as possible from pea fields of the previous year. Bury refuse and stubble after harvest and control volunteer seedlings soon after emergence. Because of sclerotinia disease, avoid field beans, lentils, mustard, canola, soybeans, safflowers and sunflowers in the rotation. For further information see Principles of Disease Control and Table 2.

Flax

For seed rot and seedling blight control, flax should be treated. (Refer to Table 1.) Follow a four year crop rotation and avoid legumes, potatoes and sugar beets because of disease. (See Table 2.)

Recommended flax varieties are rust resistant. Planting non-recommended rust-susceptible cultivars increases the risk of yield losses. To reduce the threat of pasmo and rust, use clean seed, control volunteer flax and plant early. Do not plant on or near flax stubble.

Lentils

Follow a crop rotation of four years for control of soil-borne disease. Avoid fababeans, field beans, field peas, mustard, canola, safflower, soybeans and sunflowers in the rotation because of sclerotinia disease (white mould). For further information, see Principles of Disease Control and Table 2. To prevent ascochyta blight, plant only clean, non-discolored, sound seed. If there is doubt that the seed is free from pathogens, obtain an agar plate test through the Plant Health and Plant Product Division, Agriculture Canada or an accredited laboratory. Turn under crop refuse soon after harvest, control volunteer seedlings and avoid planting lentils close to the previous year's field. To prevent anthracnose follow a crop rotation of four years. Avoid fababeans and field peas.

Mustard

Treat seed to control seed rot and seedling blights.

Follow a crop rotation of at least four years to control soil-borne diseases. Because of sclerotinia disease (stem blight), fababeans, field beans, field peas, lentils, canola, safflower, soybeans and sunflowers should be avoided in the rotation. For further information, see the Disease Control section and Table 2.

Potatoes

Crop rotations will prevent build-up in the soil of organisms that cause scab, blackleg, rhizoctonia and wilts. Avoid sunflowers, flax and rapeseed in the rotation. The plow down of a green cover crop of oats reduces rhizoctonia in the soil. Seed piece treatment reduces the risk of introducing diseases into a new field. For verticillium wilt control, treat seed pieces with thiophanate methyl (Easout). A crop rotation of four to five years is recommended. If a shorter rotation is being followed, avoid sunflowers, sweet clover, tomatoes, peppers, eggplant and alfalfa which are susceptible to verticillium wilt. Rotate with cereals.

Sanitation of all potato storage, handling and hauling equipment and disposal of all used bags is essential for bacterial ring rot control. Disinfect storage facilities and equipment with a quaternary ammonia product at a rate of 0.6 L/169 L (one pt./35 gal.) of water, or household bleach 5% solution at a rate of 700 mL/5 L (20 oz./gal.) water. Use high pressure washers or a steam cleaning unit to clean equipment before moving between fields, particularly for seed potatoes. Maintain a wet surface during disinfection for a minimum of 10 minutes.

Dispose of culls carefully to prevent plant growth. This helps to avoid contamination of the upcoming crop with bacterial ring rot or late blight. Care should be taken to plant potatoes in soil sufficiently warm for growth (approximately 7°C or 44°F) in order to control blackleg, rhizoctonia and seed piece decay. A regular spray program will control early and late blight diseases.

To control storage diseases such as silver scurf and fusarium dry rot, avoid bruising potatoes when harvesting and treat potatoes while going into storage with thiabendazole (Mertect). Mix 8 L/170 L water (1.9 gal./40 gal.), then spray 2 L solution/tonne (64 oz./ton). Do not treat potatoes being exported with thiabendazole (Mertect) at the Canadian rates.

The United States rate is about one seventh of the Canadian rate. Consult current recommendations of the country to which the potatoes are being exported.

Blight — Early blight and late blight can be controlled by fungicidal sprays. (See foliar fungicide section, page xx and Table 4.)

Follow a crop rotation of four years to control soil-borne diseases. (See Table 2.) Avoid fababeans, field peas, lentils, mustard, canola, safflowers and sunflowers in the rotation because of disease. For control of seedling rot, seedling blights, and seed maggots, apply a seed treatment as recommended in Table 1. For further information see the Disease Control section and Table 2.

Sugar Beets

Follow a crop rotation of at least four years to control soil-borne diseases (Table 2). Due to sugar beet cyst nematodes, canola and mustard should be avoided in the crop rotation. All seed is treated against damping off diseases prior to sale.

Safflower

The variety Saffire is moderately susceptible to alternaria blight and resistant to sclerotinia head rot. Other commercially available varieties may be more susceptible to alternaria blight and sclerotinia head rot.

Safflower should not follow safflower in rotation because the crop is very susceptible to alternaria blight. Because of sclerotinia disease, fababeans, field beans, field peas, lentils, mustard, canola, soybeans and sunflowers should be avoided in the rotation.

Corn

Stalk rot, which causes plants to break before harvest, is the major disease of corn in Manitoba. Organisms causing the disease are present in all soil. The disease causes severe losses and usually occurs following periods of severe stress such as drought, or prolonged cool weather. For control measures, see the Manitoba Agriculture publication *Field Corn in Manitoba*. Continuous cropping of corn can lead to a build up of stalk rot and corn smut. Seed should be treated with a suitable fungicide to prevent introduction of head smut. (See Table 1.) Rotate with cereals, other than wheat, or special crops for several years before returning field to corn. (See Table 2.) The Crop Rotation Chart published by Manitoba Agriculture contains further information on crop rotations.

Forage Grasses

Leaf diseases are the most commonly encountered and conspicuous disease problem of forage grasses. If the incidence of leaf disease becomes severe, rotate the field to other crops for several years.

Ergot can be a serious problem on bromegrass and wheat grasses. Mowing the grass at heading time will prevent the formation of ergot bodies in the developing florets. This also stops spread of the disease to nearby fields of rye, triticale, wheat or barley. After breaking up a seed field where ergot has been a problem, avoid rye, triticale, wheat or barley for one year.

Forage Legumes

Forage legumes are susceptible to a number of leaf spot diseases. They are also affected by root and crown rots which may be associated with winter injury.

Foliar diseases overwinter on infected stubble and may build up to become a serious problem. Take severely infested fields out of production. Reduce the amount of overwintering disease by cutting before leaf drop to minimize leaf loss. Early spring burning prior to new growth may also reduce leaf and stem diseases. Rotate with cereals or corn for at least one year before replanting to a forage legume. (See Table 2.)

Alfalfa and sweet clover are susceptible to verticillium wilt. To help prevent its introduction, plant alfalfa seed treated with the fungicide thiram. Avoid potatoes and sunflowers in the rotation because of common susceptibility to verticillium wilt.

Foliar Fungicide Applications for Field Crops and Potatoes

SCLEROTINA (stem rot) – Canola (rapeseed)

If necessary, sclerotinia stem rot may be controlled by an application of benomyl (Benlate R) at a rate of 0.4 to 0.6 kg/acre in 32 to 40 L/acre water for ground application, or 16 L/acre water for aerial application; or Iprodione (Rovral R Flo) at a rate of 0.8 to 1.2 L/acre in 40 L/acre of water for ground application or, 18 L/acre of water for aerial application. Higher rates of fungicide are recommended for fields with a history of heavy disease pressure or for dense crop stands.

WHITE MOULD (sclerotinia) – Field Beans

Between 50% and full bloom, apply 0.7 to 0.9 kg/acre Benlate with enough water to obtain thorough coverage. Under severe disease conditions higher rates are recommended. Do not apply within 14 days of harvest. Do not graze or feed treated bean hay to livestock.

Apply 0.4 to 0.6 kg/acre Rovral 50WP when 25 to 75% of the blooms have opened, in 18 L/acre water for aerial application and 40 L/acre water for ground application.

EARLY BLIGHT – Potatoes

To control early blight in potatoes, it is recommended that producers use one or more of several fungicides according to label directions. Frequently, such disease control measures are combined applications of insecticides where the mixture is compatible. Apply one of the following fungicides: maneb (Dithane M-22, Manzate D) at 0.88 kg/acre, mancozeb (Dithane M45, Manzate 200) at 0.88 kg/acre, metiram (Polyram 80%) at 0.88 kg/acre, Bravo 500 at 0.64 to 0.96 L/acre or fixed copper 49 to 55% at 0.44 to 1.32 kg/acre.

LEAF RUST, TAN SPOT, SEPTORIA – Hard Red Spring Wheat

Apply two applications of Dithane M45 (Mancozeb) at a rate of 0.9 kg/acre each. The first application should be made when flag leaf has totally expanded (growth stage 47 on Zadoks scale). The second application should be made 10 days later. Water volume should be 16 L/acre for aerial application, 40 to 80 L/acre ground, with a spray pressure of 345 kPa (50 psi). The preharvest interval totals 40 days.

LEAF RUST, STEM RUST, POWDERY MILDEW, TAN SPOT, SEPTORIA – Semi-dwarf and Soft White Spring Wheat.

Use Dithane M45 (Mancozeb), at the same application rate as above.

Tilt (propiconazole) can be applied on one of two application dates. Stage 1 is growth stage 30 to 37, just prior to emergence of flag leaf to when flag leaf is just visible. Application at this stage will provide early protection against powdery mildew and septoria. Stage 2 is growth stage 49 to 55, just prior to ear emergence to when ear is half emerged. This is the normal application time in Manitoba for rust, septoria and tan spot control. Apply 500 mL Tilt 250E/ha, with a water volume of 40 to 80 L/acre for ground application and 16 L/acre for aerial application. Spray pressure should be 200 to 500 kPa (30 to 45 psi). Preharvest interval is 45 days.

LEAF RUST, STEM RUST AND POWDERY MILDEW – Winter Wheat

Treatment with Dithane M45 (Mancozeb) is the same as for hard red spring wheat.

Tilt (propiconazole) treatment is the same as for semi-dwarf and soft white spring wheat.

Bayleton (triadimefon) should be applied at growth stage 37 to 39 (Zadoks scale) at emergence of flag leaf. Use 100 to 200 g/acre, with a water volume of 40 to 120 L/acre, ground application only. Preharvest interval is 60 days.

NET BLOTCH, SPOT BLOTCH, SCALD, POWDERY MILDEW, SEPTORIA, LEAF RUST – Barley

With Tilt (propiconazole), application date is between growth stage 20 and 32 and growth stage 45 and 50, depending on leaf disease development. Normally growth stage 45 and 50 is recommended in Manitoba. Apply 200 mL Tilt/acre with a water volume of 40 to 80 L/acre for ground application or 1.6 L/acre aerial. Spray pressure should be 200 to 300 kPa (30 to 45 psi). Preharvest interval is 45 days.

Fungicides

Trade Name/Common Name

Bayleron (Triadimefon)
Benlate (Benomyl)
Bravo (Chlorothalonil)
Captan (Captan)
Dithane M-22 (Maneb)
Dithane M-45 (Mancozeb)
Dyrene (Anilazine)
Easout (Thiophanate Methyl)
Fixed Copper 50W (Fixed Copper)
Kocide (Fixed Copper)
Manzate D (Maneb)
Manzate 200 (Mancozeb)
Mertect (Thiabendazole)
Polyram (Metiram)
Pro-Gro (Carbathiin-Thiram)
Rovral (Iprodione)
Thiram (Thiram)
Tilt (Propiconazole)
Vitavax 280 (Carbathiin)

Danger Warning Caution

Major Fungicides Used on Cereals, Potatoes, Special Crops and Vegetables

Anilazine

A broad spectrum protective foliar fungicide recommended for control of foliar diseases of vegetables.

Trade name: Dyrene
Registrants: Chemagro Ltd.

Benomyl

A systematic fungicide for control of white mould on snap beans, field beans and canola.

Trade names: Benlate 50WP
Benolin R (seed treatment)
Gammasan+ (seed treatment for canola)
Thiralin+ (seed treatment for canola)

Registrants: ICI Chipman Chemicals Ltd.
Dupont of Canada Ltd.
Rhone Poulenc Canada Inc. (seed treatment)
Inter-Provincial Co-op (seed treatment)

Captan

A fungicide used primarily as a seed treatment on special crops and vegetables.

Trade Names: Captan
Orthocide

Registrants: Ciba-Geigy Canada Ltd.
ICI Chipman Chemicals Ltd.
Chevron Chemical (Canada) Ltd.
Pfizer Co. Ltd.
Stauffer Chemical Corp. of Canada
Gustafson

Carbathiin

A systemic fungicide effective against various seed-borne smuts, blackleg of canola and seedling blights of cereals and special crops. It is applied to the seed at planting time. Various formulations are registered for use on wheat ,oats, alfalfa, onions, barley, rye, flax, canola and mustard.

Trade names: Vitavax, Vitavax RS (seed treatment for cereals, flax, canola, mustard)
Anchor (seed treatment for wheat, barley, oats, flax, rye, triticale and soybeans)
Pro-Gro (seed treatment for onion smut)

Registrant: Gustafson

Chlorothalonil

A broad spectrum protectant fungicide used to control foliar diseases of vegetables and potatoes.

Trade names: Bravo
Registrants: Formenta

Copper (Fixed)

A broad spectrum fungicide and bactericide. Fixed copper controls foliar diseases caused by fungi and bacteria on sugar beets, beans, potatoes and some vegetables. Copper compounds are also used as algicides and wood preservatives. There are several different forms of fixed copper fungicides.

Trade names: Fixed copper 50W
Kocide 101

Registrants: Pfizer Co. Ltd.
Rhone Poulenc Canada Inc.

Kocide Chemicals Co. Chemical Corp.

Iprodione

A broad spectrum contact fungicide, is registered for control of sclerotinia disease affecting canola, field beans and snap beans and as a seed treatment for canola to control blackleg. It is also registered for control of botrytis fruit rot of strawberries.

Trade names: Rovral 50WP, Su
Rovral ST, Su

Registrants: Rhone Poulenc Canada Inc.

Mancozeb

A contact fungicide with protective action for use in controlling fungus leaf diseases of vegetables and potatoes. It is also registered for control of covered smut and false loose smut of barley, smut of oats, bunt of wheat, seedling blight and seed rot of flax. Mancozeb has a similar activity to maneb. Dithane M45 is registered for control of leaf rust, tan spot and septoria on all types of wheat.

Trade names: Manzate 200
Dithane M45

Registrants: Dupont of Canada Ltd.
Ciba-Geigy Canada Ltd.
Rohm & Haas Co. of Canada Ltd.
ICI Chipman Chemicals Ltd.

Maneb

Maneb is a general purpose and broad spectrum fungicide used to control potato and vegetable foliar disease. It has a protectant and an eradicant action. Maneb is registered as a seed treatment for control of covered and false loose smut of barley, bunt of wheat and smut and seedling blight of oats by several companies. (See seed treatment table.)

Trade names: Maneb
Manzate D
Dithane M22
Agrox (see seed treatment table)
Mergamma (see seed treatment table)

Registrants: ICI Chipman Chemicals Ltd.
Rhone Poulenc Canada Inc.
Alberta Wheat Pool (seed treatment)
Dupont of Canada Ltd.
Interprovincial Co-ops Ltd. (seed treatment)
Pfizer Co. Ltd.
Rohm & Haas Co. of Canada Ltd.
Saskatchewan Wheat Pool (seed treatment)

Metiram

A protectant action fungicide for foliar diseases of potatoes and vegetables. It is also used as a potato seed piece treatment.

Trade names: Polyram
Registrant: BASF Canada Inc.

Propiconazole

A fungicide with both protectant and eradicant action, registered for control of leaf and stem rust, tan spot, septoria and powdery mildew of winter wheat, prairie spring (semi-dwarf) and soft white wheat varieties.

Trade names: Tilt
Registrants: Ciba-Geigy Canada Ltd.

Thiabendazole

A broad spectrum preventative curative fungicide with activity similar to benomyl and thiophanate methyl. It is registered for use on

potatoes as a post-harvest (pre-storage) application for control of storage diseases as well as for control of leaf spot of sugar beets, and as a seed treatment for blackleg of canola.

Trade names: Mertect
Premier

Registrants: ICI Chipman Chemical Ltd.
Ciba-Geigy Canada Ltd.

Thiophanate-Methyl

A broad spectrum preventative curative systemic fungicide closely related to benomyl and thiabendazole. It is used as a seed piece treatment for potatoes.

Trade names: Easout
Registrants: Ciba-Geigy Canada Ltd.

Thiram

A broad spectrum protective action fungicide, used mainly as a seed treatment for cereals, special crops and vegetables, and verticillium wilt of alfalfa.

Trade names: Anchor
Thiram
Dasinet & Thiram 5% to 10% Granular (for onion smut control)
Ethion 5 Thiram 7.5-G Granular (for onion smut control)
Pro-Gro (for onion smut control)

Registrants: Gustafson
Pfizer Co. Ltd.
Stauffer Chemical Co. of Canada Ltd.
Dupont of Canada Ltd. (seed treatment)
Chemagro Ltd.
Rhone Poulenc Canada Inc.

Triadimefon

A fungicide with both protectant and eradicant activity. It is effective against leaf and stem rust and powdery mildew of wheat and is registered for use only on winter wheat.

Trade name: Bayleton
Registrants: Chemagro Ltd.

Fungicide Index

Chemical	Trade Names
Anilazine	Dyrene
Benomyl	Benlate, Benolin R, Gammasan+, Thiralin+
Captan	Captan, Orthocide
Carbathiin	Anchor, Vitavax, Pro-Gro
Chlorothalonil	Bravo
Copper (fixed)	Kocide 101, Fixed Copper 50W
Iprodione	Rovral
Mancozeb	Manzate 200, Dithane M45
Maneb	Agrox, Maneb, Manzate D, Mergamma, Dithane M22
Metiram	Polyram
Propiconazole	Tilt
Thiabendazole	Mertect, Premier
Thiophanate-methyl	Easout
Thiram	Pro-Gro, Thiram, Anchor
Triadimefon	Bayleton

Table 1: Seed Treatment Fungicides and Insecticides

ACTIVE INGREDIENT	INSECT: Wireworms: Wheat	Oats	Barley	Rye	Flax	Seed Maggots: Field Beans	Corn	Soybeans	Flea Beetles: Canola (Rapeseed)	Mustard	DISEASE: Seed and Seedling Rots/Blights: Canola (Rapeseed)	Mustard	Peas	Cereals	Flax	Rye	Corn	Field Beans	Soybeans	Smuts Carried: On Seed: Corn-Head Smut	Rye-Stem Smut	Wheat-Bunt	Oats-Smut	Barley-Covered	Barley-False Loose	In Seed: Wheat-Loose Smut	Barley-False Smut	Blackleg: Canola (Rapeseed)	Verticillium Wilt: Alfalfa
INSECTICIDES																													
carbofuran (Gr)									●	●																			
lindane (Wp)	●	●	●	●		●	●																						
terbufos (Gr)									●	●																			
FUNGICIDES																													
benomyl-thiram (Du)											●																	●	
captan (Du, Wp)													●				●	●	●										
carbithiin (Sn)															●	●					●	●	●	●	●	●	●		
carbithiin-thiram (Du) (Su)														●●	●●	●●	●		●●	●	●●	●●	●●	●●	●●	●●	●●	●●		
maneb (Du, Su)														●	●	●							●	●	●	●			
mancozeb (Wp)															●								●	●	●	●			
thiram (Su, Wp)											●	●	●				●	●	●										●
DUAL PURPOSE																													
benomyl-captan-lindane (Du, Su)									●	●	●	●																●	
iprodione-lindane (Su)									●		●																	●	
benomyl-thiram-lindane (Du)									●		●																	●	
captan, diazinon (Wp)						●	●	●					●				●	●	●										
captan, thiophanate-methyl, diazinon (Du)																		●											
captan-lindane-diazinon (Du)						●	●	●					●				●	●	●					●					
carbathiin-lindane (Su)	●	●	●											●								●	●	●	●	●	●		
carbithiin-thiram-lindane (Du) (Su)	● ●	●	● ●	●	●				●	●	●	●		●●	●	●					●	●● ●●	● ●	●● ●●	●● ●●	●● ●●	●● ●●		●
maneb-lindane (Du)	●	●	●	●										●								●	●	●	●				
thiabendazole, thiram-lindane (Su)									●		●																	●	

Gr=Granules
Du=Dust
Sn=Solution
Su=Suspension
Wp=Wettable powder

Table 2: Crop - Disease Relationships

For Crop Rotation Considerations

DISEASES	ALFALFA	BARLEY	BUCKWHEAT	CORN	FABA BEANS	FIELD BEANS	FIELD PEAS	FLAX	LENTILS	MUSTARD	OATS	POTATOES	CANOLA	RYE	TRITICALE	SAFFLOWER	SOYBEANS	SUGARBEETS	SUNFLOWERS	SWEET CLOVER	WHEAT	LONGEVITY
ASCOCHYTA BLIGHT					A		B		C													4
ALTERNARIA-GREY LEAF SPOT										X			X									1
BACTERIAL BLIGHT						A	B										C					1
CYST NEMATODE										X			X					X				3
ERGOT		X												X	X						X	1
FUSARIUM WILT AND ROOT ROT	X				X	X	X	X	X	X			X				X		X	X		S
FUSARIUM HEAD BLIGHT (SCAB)		X		X																	X	1
COCHLIOBOLUS - FUSARIUM COMMON ROOT ROT		X																			X	2
RHIZOCTONIA ROOT ROT	X		X		X	X	X	X	X	X		X	X				X	X	X	X		S
SCLEROTINIA	X				X	X	X		X	X		X	X			X	X		X	X		4
SEPTORIA (CEREALS)		A									B										C	1
VERTICILLIUM WILT	X											X							X	X		4
WHITE RUST - STAGHEAD										A			B									3

Diseases with different letters have same name on various crops but are caused by different species or biotypes of the pathogen. This implies that there is little risk of the disease spreading between the indicated crops.

* = longevity of pathogen in soil or on trash in years
S = pathogen is a soil organism and can survive indefinitely
X = diseases can occur on crop

Table 3: Foliar Applied Fungicides

Wheat, Barley, Cereal, Field Beans and Potatoes

		ACTIVE INGREDIENT									
		anilazine	benomyl	chlorothalonil	fixed copper	iprodione	mancozeb	maneb	metiram	propiconazole	triadimefon
LEAF RUST	Hard Red Spring Wheat						•				
	Semi-dwarf						•			•	
	Winter Wheat						•			•	•
	Barley									•	
STEM RUST	Hard Red Spring Wheat										
	Semi-dwarf									•	
	Winter Wheat									•	•
SEPTORIA	Hard Red Spring Wheat						•				
	Semi-dwarf						•			•	
	Winter Wheat						•			•	
	Barley									•	
TAN SPOT	Hard Red Spring Wheat						•				
	Semi-dwarf						•			•	
	Winter Wheat						•			•	
POWDERY MILDEW	Hard Red Spring Wheat										
	Semi-dwarf									•	
	Winter Wheat									•	•
	Barley									•	
NET BLOTCH SPOT BLOTCH, SCALD	Barley									•	
SCLEROTINIA	Canola		•			•					
	Field Bean		•			•					
BACTERIAL BLIGHT	Field Bean				•						
EARLY OR LATE BLIGHT	Potatoes	•		•	•		•	•	•		